(continued from page 1 - Climate Change and the Future of Air Travel)

Day to day variability in atmospheric conditions was also found to have a substantial effect on the ability of simple altitude restrictions to be an effective policy. Current work is aiming to examine more complex aircraft routing strategies aimed at avoiding air masses that lead to persistent contrail formation.

At present the production of contrails and their effect on the environment is not taken into account in government assessments of the environmental impact of air travel. Team leader, Dr. Robert Noland, thinks it should be. He says, "We'd like this research to inform government policies, not just in the UK but throughout the rest of the world so that decision makers can take all the environmental issues into account and do the right thing."

Dr. Noland also believes that the work has direct relevance to aircraft manufacturers. He says, "There is little more that aircraft designers can do to increase engine fuel efficiency at high altitude, but designing new aircraft that can be as fuel efficient flying at 20,000 feet, as today's aircraft are at 35,000 feet, would help eliminate contrails."

This photo shows the extensive build-up of persistent contrails resulting from its location along the East Coast flyway. Some of these contrails are showing signs of spreading, but the spreading is not particularly pronounced. There are also some natural cirrus clouds visible in the mix.

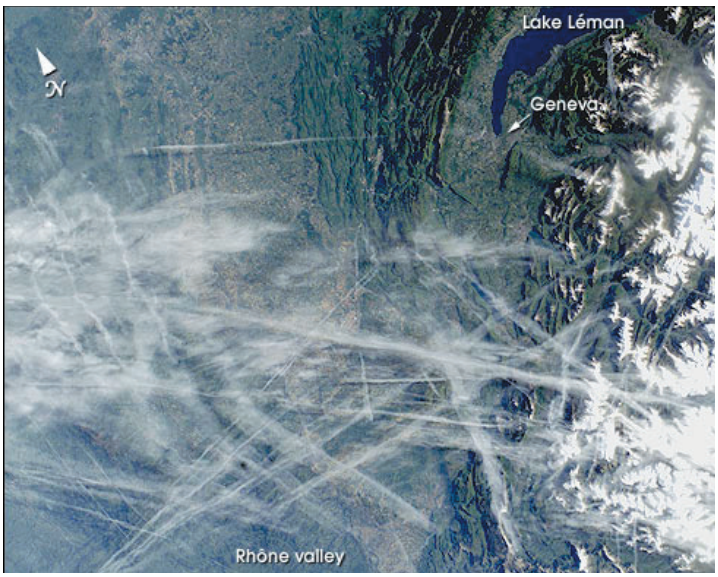
A key consideration in this study is the proliferation of short-haul flights. These are currently thought to be more environmentally disruptive than long-haul flights because of the high quantity of fuel needed for take-off and landing. In a short haul, this is not balanced by a long, fuel-efficient cruise. However, contrail effects are not taken into account in current assessments of air travel. The team is investigating whether the picture would change if they were. The reason is that short-haul flights seldom reach the altitude where contrails form and this might make them overall more environmentally friendly than high-flying long-haul flights.

As well as the seasonal variation in atmospheric conditions, which the team estimated would require a general ceiling on flight altitudes (summer: 31,000 feet, winter: 24,000 feet), they also found significant day to day variations, so any contrail reduction strategy would work better if it were reactive on a daily basis. They also found days when the atmospheric conditions made it almost impossible to avoid contrail formation.

Aircraft already measure the exterior air conditions, so a simple piece of software, programmed with the details of the jet exhaust temperature and humidity could immediately alert a pilot to when his aircraft is creating a contrail. Although lower flying aircraft expend more fuel to push themselves through the thicker atmosphere, the team found this less damaging than the radiative forcing effect of the contrails. Lower altitude flying does, however, slightly increase travel time.

Radiative forcing is any change in the balance between radiation coming into the atmosphere and radiation going out. Positive radiative forcing tends to warm the surface of the Earth, and negative radiative forcing tends to cool it. This effort is being led by Dr. Robert Noland in Civil & Environmental Engineering. Dr Ralf Toumi in the Physics Dept is the co-investigator and Dr. Victoria Williams in Civil & Environmental Engineering is an EPSRC-funded Research Fellow.

The Engineering and Physical Sciences Research Council (EPSRC) is funding the work, which is a joint effort between the Department of Civil & Environmental Engineering and the Department of Physics at Imperial College London.
For more information visit EPSRC at: http://www.epsrc.ac.uk/



Digital photograph taken through the windows of the International Space Station shows contrails over Eastern France.

(continued from page 2 - NASA Scientists Use Empty Skies...)

The air traffic shutdown gave Minnis and his team the chance to track individual, persistent contrails from military aircraft on September 12.

"Six aircraft were responsible for the formation of cirrus clouds that covered more than 20,000 square kilometers within an area between Virginia and central Pennsylvania," said Minnis. "During normal days, the area is crossed by thousands of jetliners that could each produce contrails similar to those from the military jets."

The results of the study provide the basis for improved prediction of persistent contrails and their effects on climate.

"If scientists determine that contrails are negatively impacting climate change, we could minimize their formation by predicting where they will occur and then suggesting alternate flight altitudes accordingly, when feasible," said Minnis. David Duda, of Minnis' team, has used improved estimates of relative humidity (the amount of water vapor in the atmosphere) from Minnis' study to enhance computer simulations of contrails and their predictability.